

EXECUTIVE SUMMARY

DEVELOPMENT OF DESIGN CONSIDERATIONS FOR: *RESTORING NATURAL PROCESSES* TO STREAMS AND RIVERS IN THE SACRAMENTO AND SAN JOAQUIN BASINS

Project Description and Primary Biological/Ecological Objectives

The proposed project involves a research study of the application of fluvial geomorphology in stream restoration designs, specifically addressing conditions in the Sacramento and San Joaquin Basins. The purpose is to provide restoration designers and project sponsors with a methodology and database geared specifically to CALFED streams. Loss of natural stream physical processes is denoted as a key stressor for many CALFED priority species and habitats in the Category III RFP and technical team reports. However, there are no guidance documents on how to approach restoration design, what questions must be answered, how to obtain needed information, and there is little reduced and analyzed data available on the subject streams. Much of the design information available is not directly applicable to CALFED streams, and given that several project failures have occurred recently, it would be timely to construct standard methodologies and a relevant stream database. Moreover, the unique character of CALFED streams, owing to the dramatic historical changes associated with water resources development, must be addressed in a more rigorous manner to provide the greatest chances of success.

Approach / Tasks / Schedule

The study involves a combination of field data collection, analysis of historical stream flow and characteristics, a review of successful and failed restoration projects, peer review by a preeminent steering committee, preparation of design guidance report and the convening of workshops. The key products will be an analysis of channel forming flows versus flow statistics, a regionalized database of channel geometry, a "road map" design protocol for designing a restoration project and workshops for parties involved in restoration projects. It is anticipated that the project will take 18 months to complete. Individual data analyses shall be published with description and analytical memoranda upon completion. Coordination with the Steering Committee shall be done at no less than a quarterly basis.

Justification for Project and Funding by CALFED

The proposed project will aid in the design of river and stream and enhancement and restoration projects within the CALFED area. The product would provide guidance for restoring habitat in a range of channel conditions. Little or no relevant data, design protocol or critical assessments of restoration projects exist for CALFED streams. With the CALFED mandate involving a significant amount of restoration and the alteration of existing channel geometry and geomorphic processes, it behooves CALFED to establish a standard design process to ensure that the best information and methods are available for success. No other funding sources have been identified to address geomorphic processes for restoration as broadly as we propose.

Budget Costs and third Party Impacts

The proposed budget is \$205,230.00. No third party impacts would occur as the proposal involves a study of the application of fluvial geomorphology.

Applicant Qualifications

Mitchell Swanson is a senior fluvial geomorphologist with over fifteen years of consulting experience related to restoration and resource management of large rivers, streams, and wetlands. He holds B.S. and M.S. degrees in earth sciences, with concentrations in fluvial geomorphology, sedimentary geology, and hydrology. He specializes in the development of technically and environmentally sound management and restoration plans for rivers and watersheds. A special focus involves the development of systematic field data collection and analysis programs tailored to the specific needs and resources of the individual project. His technical expertise includes historical geomorphic and hydrologic studies and in determining the causes and effects of human modification on natural systems. Mr. Swanson has led efforts to integrate bioengineering and geomorphic principles into bank and stream stabilization projects. Mr. Swanson has become a recognized expert in conflict resolution between government agencies, and public and private interests.

Toby Hanes is a Registered Professional Hydrologist and Certified Professional Erosion and Sediment Control Specialist with 21 years of experience. He holds a B.S. in watershed sciences and a M.S. in Wildland Hydrology with academic concentration in natural channel hydraulics and sediment transport, physical process watershed modeling, and soil-plant-water relationships. Mr. Hanes' career includes positions as a field hydrologist with the U.S. Geological Survey and 13 years with the U.S. Forest Service, with positions at all levels of the agency from Ranger District to the Washington D.C. Office. Pertinent experience includes five years as Forest Hydrologist at the Lake Tahoe Basin Management Unit, where he was directly responsible for a number of stream and wetland restoration projects. For the last nine years, Mr. Hanes has been in private consulting and established Hydro Science in 1990. Mr. Hanes has designed and supervised construction on numerous stream and wetland restoration projects and has had two on-call services contracts with the California Tahoe Conservancy to provide such services.

Monitoring and Data Evaluation

The proposed project is a study, therefore monitoring is not needed. However, monitoring procedures will be evaluated for developing recommendations to achieve an optimum adaptive management feedback.

Local Support/Coordination with Other Programs/ Compatibility with CALFED

The proposed study will benefit many programs within and outside of the CALFED area. The project will be coordinated with the University of California ongoing research programs. The proposed project is highly relevant to CALFED program that should involve a significant number of restoration projects.

Proposal for CALFED Category III Funding:

DEVELOPMENT OF DESIGN CONSIDERATIONS FOR:

RESTORING NATURAL PROCESSES

TO STREAMS AND RIVERS IN THE SACRAMENTO AND
SAN JOAQUIN BASINS

Applicant:

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RFP Project Group: Group 3 Other Services

Project Description and Approach

CALFED has identified a host of hydrologic and geomorphic stressors limiting recovery of the CALFED priority species, including hydrologic isolation of the floodplain, channelization, bank armoring and flow alterations. The Category III Ecosystem Restoration emphasizes the restoration of “natural” processes as the preferred means of regaining ecological function in the Delta and its tributaries. Unfortunately, the scientific basis for restoring natural function in streams and rivers is quite low in California. There have been a number of what might be considered recent failures, either real or perceived, of applying fluvial geomorphic techniques to restoring streams in California. These failures, we believe, are primarily due to the following problems:

- 1) A lack of problem definition and what type and magnitude of restoration is appropriate, realistic and cost effective. Often, it is assumed that full-scale channel reconfiguration is the only means to restore habitat or habitat creating physical processes. In reality, habitat quality is often driven by a diversity of landscape surfaces (flood plain, terrace, pool, riffle, bar etc.) and substrates, a healthy riparian shoreline, and in-stream cover. These can often be achieved by simply restoring diverse hydraulic mechanisms that sort gravels and deposit them in useable sites and allow for deposition of fine mineral soils to promote riparian vegetation. In the Sacramento / San Joaquin River system, loss of hydraulic diversity is one of the key outcomes of the past 100 years of channelization, snag removal, loss of woody debris and sediment sources and sustained flushing through reservoir flood releases. Often, what is a hydraulic diversity problem is treated as a sediment supply problem and an expensive and sometimes unsuccessful gravel replenishment or riffle creation project is undertaken. The problem in many cases may be a lack of slackwater, flow separation and hydraulic diversity. It is important that the resource manager understand what the physical process problems are before undertaking a program to fix it.
- 2) When a channel restoration project involves reconfiguration of the channel, failures have occurred because several popular “rules of thumb” of fluvial geomorphology concepts have been applied. While these “rules of thumb” have been strictly adhered to, the relations were developed outside of California or in very limited regions of California (i. e. coastal watersheds) with vastly different climate, streamflow and geomorphic processes. There must be a sound basis for choosing design parameters of channel width, depth and grade and a thorough understanding of the hydraulics of the system and what forces the restored channel will be exposed to.
- 3) A third problem is that the application fluvial geomorphology is carried out by practitioners who are well meaning but have limited experience or training to understand site-specific processes and characteristics, or man-induced changes. The project designers, be they fisheries biologists, riparian ecologists, hydrologists, or civil engineers, need a “road-map” in order to ensure that all of the important geomorphic processes have been identified and addressed.

Given CALFED’s mandate, the current state of applying fluvial geomorphology to restoration in California with several recent project failures (Uvas Creek, Wulff Creek, Cold Creek), we see an

enormous potential for ill-designed projects. Projects may not only fail to meet their stated objectives, but could actually have greater ecological impacts than benefits. We believe there is a critical need to develop regionalized empirical relationships, refine existing fluvial geomorphic design concepts, develop a "road map" for problem definition and design and advance the collective knowledge through case studies. Specifically, the following measures are recommended:

1. Develop a standard, problem-definition road map that could be used to understand the underlying physical processes of the subject stream and whether enhancement of existing features or full restoration is the appropriate measure.
2. Validate or refine the relationship between the 1.5-year recurrence interval flood and bankfull flow and develop regionalized relationships of bankfull geometry.
3. Examine the appropriateness of using the 1.5-year recurrence interval flood as a design parameter on regulated streams, and develop recommendations for alternate approaches where suitable.
4. Examine the appropriateness of using the "historic analog" of channel planform and width where sediment supply and flow regime have been altered through the construction of upstream reservoirs. Provide methodologies to help interpret important geomorphic processes through interpretation of historical and geological data.
5. Ascertain the extent, if any, that floodplain/valley width and recent flow history may have on field indicators of bankfull flow.
6. Examine the influence of the large variability in peak flows commonly exhibited in California rivers and streams on channel planform stability and the appropriateness of using the 1.5-year flood flow as a geomorphic design parameter.
7. Perform a case-study review of recent stream and river restoration projects in California to ascertain current strengths and weaknesses in stream restoration design.

Project Description and Approach

The applicant proposes to conduct the investigations listed above in a comprehensive manner in order to advance the state-of-the-art of fluvial geomorphic design principles for use in restoring natural processes on rivers and streams in the Sacramento and San Joaquin watersheds. The final product of the study would be the development of a "design guidance" report. This report would identify appropriate fluvial geomorphic design approaches for in CALFED region streams. It would illustrate unique design constraints and other important considerations relevant in this region; for example special consideration would be devoted to the development of design procedures for channels with altered geometry (levees), sediment supply (dams, gravel mining), and regulated flows. The report would also include standard literature content and format of

regionalized relationships of bankfull flow versus drainage area, and width, depth, and cross-sectional area versus bankfull flow.

These investigations would be field-intensive and undertaken directly by senior hydrologists and fluvial geomorphologists with many years of direct experience in stream and river restoration. Products would be reviewed by distinguished experts fluvial geomorphologists, including Dr. Luna Leopold, Emeritus Professor of Geology and Landscape Architecture, University of California at Berkeley and former Chief Hydrologist of the U.S. Geological Survey, Dr. G. Mathias Kondolf of University of California at Berkeley and Dr. Jeffery Mount, Department Head, Geological Sciences, University of California at Davis. Hydrologic studies would be based on field studies where U.S. Geological Survey and California Department of Water Resources gaging stations and streamflow measurement data are applicable.

We are proposing a very structured scope of work with a number of distinct deliverables and milestones to accommodate shifts in emphasis based on interim findings and peer review. We are also proposing that work plan development be a part of the project so that we can maximize its responsiveness to CALFED and interested agencies and stakeholders.

Location

Due to realistic limitations on dismantling existing levees and associated infrastructure on the main stem of the Sacramento and San Joaquin Rivers, the bulk of study effort would be devoted to principal tributaries, both above and below major reservoirs, *with primary emphasis on streams that have a high potential for restoring natural processes.* However, measures that enhance habitat development on overly encroached streams will be addressed on the main trunk streams. *Specific study areas would be identified during work plan development as data availability is reviewed and site visits are completed.* Case study reviews should not be limited to the study area boundaries, since there are so few to drawn upon.

Expected Benefits

Given CALFED's mandate and its emphasis on using natural processes in ecosystem restoration, it follows that a number of large and expensive river and stream restoration projects will be proposed and funded using fluvial geomorphic design approaches. Our concern is that the state-of-the-art of stream restoration in California is currently insufficient to reliably achieve project success, i.e., many of these projects could "back-fire". We need to refine existing fluvial geomorphic design concepts for specific application to the Bay-Delta program, and consolidate the current fragmented state-of-the-art of stream restoration in California. We anticipate that the results will dramatically improve the success of future CALFED funded restoration projects, and assure that taxpayer funds expended for this program are dollars well spent. *Our familiarity with recent stream restoration efforts in California leads us to believe that funding this grant application will be a wise investment with broad applicability to CALFED restoration goals for the long run. These primary benefits include the creation of durable, resilient instream habitat (spawning, feeding, and escape cover) and shaded riverine aquatic (SRA) habitat, which will directly benefit salmonids. Important secondary benefits would occur for seasonal wetland and riparian dependent species. We anticipate that the study will have "spin-off" benefits that will*

routinely improve the success of future restoration projects undertaken by CALFED, CVPIA, or any other funding programs for many years in the future.

Background and Biological/Technical Justification

Proper restoration of natural physical processes should be the basis for sustainable instream, wetland, and riparian habitat restoration. Over years of experience, we have viewed many examples of well-intentioned but doomed efforts to improve instream and riparian habitat or to stabilize eroding banks using bioengineering approaches in the absence of the designer's understanding of the rivers' current and potential state, i.e., a "system" perspective was lacking. We have also viewed many instances throughout the West where instream structural habitat improvements have not accounted for high flow hydraulic forces and have either "blown out" during high flows or actually induced additional channel erosion. "Green" bioengineering techniques have been used in an attempt "restore" streams by laying back eroding banks and applying a variety of planting and "soft" stabilization approaches. Yet field analogs show that creation of even a very small floodplain (5-50 feet wide) at the correct elevation through bank excavation creates both an ideal riparian planting zone, restores natural riparian recruitment processes and is thus self-sustaining. The root mass within a very confined floodplain can control low bank retreat, and will tend to form the undercut bank which provides excellent cover, while the hydraulic roughness of the riparian vegetation can lower flood flow velocities and arrest bank erosion, thereby allowing eroding banks to revegetate naturally.

The applicant's perspective is that performing correct "physical" restoration brings about the requisite system "state" for sustainable habitat restoration to be accomplished with limited further intervention.

While CALFED recognizes the validity of restoring natural processes, we believe that most practitioners lack the "tools" to do the work effectively and reliably. True stream and river restoration is typically a high-risk venture, even under the best of circumstances. It is probably fair to conclude that the California experience, to date, has not been positive. Most of the relationships used to define bankfull flow and hydraulic geometry for use in California can be considered first approximations. There is a dire need to develop more relationships targeted to individual areas.

There also is a tendency for designer's to reconstruct channels in California with excessive sinuosity, which have resulted in their partial to complete failure. We believe that there are critical relationships between the commonly high flow variability and the tendency for lower sinuosity in many California streams that have not been recognized and can directly impact project success. This study would allow us to ferret out relationships between flow duration, peak flow variability, valley and floodplain width which may directly alter existing commonly used relationships involving the use of the 1.5-year event as the basis for design. We suspect that in areas which lack a dominance of flows closely associated with the 1.5-year event and which have high variability in annual peak flows, the use of the 1.5-year flood flow may only provide the initial starting point in channel restoration design. In such cases, channel forms may be

hybrids, with a low-water channel that is designed around high, long duration flows less than the 1.5-year event, and a floodway channel which may have a lower sinuosity. Developing these relationships becomes increasingly important for use on smaller basins which are naturally more “flashy” than the “dampened” larger river systems. Certainly, however, the same type of problems face designers in working with highly regulated systems where the flow and flood regime has been significantly altered, and the geomorphic relationship, and significance, between bankfull and the 1.5-year flow has shifted.

Scope of Work

We believe that having a contractual structural that is flexible will be advantageous to CALFED. As a result, the tasks listed here form a basis for the project, we anticipate changes through the development of the work plan and refinements as the study progresses.

Task 1: Work Plan Development In consultation with CALFED, a 5-7 member steering committee would be formed to assist in developing a work plan that is most responsive to the CALFED program. Assemble candidate list of study streams and rivers and pertinent characteristics. Quarterly meetings would be held following project initiation to present interim results and to redirect future work as needed.

Task 2: Perform Bankfull Flow Surveys Field survey bankfull flow at 30-40 gaged rivers and streams as approved by the steering committee.

Task 3. Compare Differences in Field Estimates of Bankfull Flow and 1.5-Year Peak Flow Using published annual peak flow data, perform a flood frequency analysis for each station and compare estimated bankfull flow as measured from field indicators to computed 1.5-year and 2-year recurrence interval peak flows. Assess data for systematic differences related to flow duration, persistence of moderate-to-high flows, peak flow variability, channel classification, hydrologic province, mixed hydrology (rain-on-snow versus snowmelt), recent flow history, and floodplain width.

Task 4. Develop Regionalized Bankfull Relationships Using both surveyed bankfull data, and the 1.5-year event as a proxy for bankfull, develop regionalized relationships of bankfull flow versus drainage area, and bankfull flow versus channel width, depth and cross-sectional area. Relationships would be developed using USGS streamflow measurement data from gaged streams.

Task 5. Examine Relationships Between Channel Planform, Flow Characteristics, Floodplain Width, and Riparian Area Condition The objective of this task is to determine if there are other, more accurate predictors of channel planform, primarily sinuosity, using independent variables other than, or in addition to either bankfull flow or the 1.5-year peak flow. This could take the form of a multiple regression analysis to develop, for example, predictive equations of channel sinuosity. Likely initial parameters which might be examined would be some expression of peak flow variability, persistence of flows near bankfull, floodplain and valley width, and extent of riparian cover.

Task 6. Identify Changes in Channel Planform and Width Induced By Flow Regulation and Diminishment of Sediment Supply

There may be many instances where levee set-backs might be proposed. An important question is "How Far?" The first approximation of allowing a return in natural processes, i.e., allowing a return to a meandering channel form would be to define the pre-reservoir meander belt width using historical photography. This approach may overestimate the required present-day belt width since the flow regime has changed. The objective of this task would be to identify channels that have become regulated but were not excessively confined, where changes in planform in response to flow regulation could be studied. If sufficient examples are available, we may be available to develop guidelines for modifying predicted planform using techniques developed in earlier tasks.

Task 7. Stream Restoration Case Studies

Up to seven relevant stream restoration projects would be examined to assess their success and to identify commonalities regarding successful and failed projects. Design documents and background studies would be examined. From this examination, and examination of other successful and failed projects, a "road map" of project development would be compiled. This road map would contain a list of specific and relevant questions that should be addressed as a design is developed.

Task 8. Final Report

Prepare a final report compiling the results of the above tasks and to develop "design guidance" for future stream and river restoration projects

Task 9. Fluvial Geomorphic Design Workshops

Hold two 1-day (or greater if required) workshops to present study findings and provide guidance to project designers. Gather feedback on how to finalize guidelines in order to maximize usefulness.

Task 10. Program Management

Given the large and comprehensive nature of this project, a separate task is proposed to fund steering committee interaction, administrative matters, coordination with CALFED, meetings, and peer review.

Monitoring and Data Evaluation

No monitoring is proposed given the nature of this project. However, we will try to re-construct the reasons for project success and failure and define appropriate monitoring methods so that an "adaptive management" feedback loop of refinement can be implemented. The final report will include recommendations for monitoring and adaptive management.

Implementability

Since no physical action or change in management will take place as part of this project, there are no restrictions to "implementability" and no permits required. There may be some restrictions in implementing individual tasks depending on the availability of historic aerial photographs and status (archived or not) of pertinent USGS streamflow data. However, a recent similar study we conducted showed that USGS data availability is very good.

Costs and budget to Implement Proposed Project

a. Proposed Costs

The proposed project costs are shown in **Table 1 (attached at the end of the text)**. CALFED funding is needed to support basic needed research to develop the tools for restoring rivers, streams and habitats within the CALFED area. While funding can be secured to do individual site analyses, there are no known funding sources for a regionalized geomorphic design analysis of the proposed scale. Given the importance of the data and information we propose to produce for CALFED projects, and the potential money that is about to be spent, we believe that this proposal is a worthwhile investment. We have not identified other funding sources at this time. We do not anticipate the need for subcontractors except for the Steering Committee members who will be selected by unique qualifications per the appropriate State contracting procedures.

b. Schedule Milestones

We anticipate that the project will take 18 months to complete. We anticipate intensive interaction with CALFED and our proposed steering committee on no greater than a quarterly basis. Data and memorandum will be circulated as they are completed. Monthly progress reports will be provided. Final report will be completed in Month 12 before proposed workshops.

<u>Task</u>	<u>Milestone (Month Number)</u>
1- Work Plan Development*	Completed Month 1
2- Perform Bankfull Flow Surveys*	Completed Month 6 (flows permitting)
3- Compare Field Data and Statistics*	Completed Month 8
4- Develop Regional Relations*	Completed Month 9
5- Relations Analysis*	Completed Month 10
6- Flow Regulation Sediment Impacts*	Completed Month 10
7- Stream Restoration Case Studies*	Completed Month 10
8- Draft* and Draft Final Reports*	Completed Month 12
9- Workshops	Completed Month 15
Final report*	Completed Month 18

Notes:

* Denotes product delivery

Applicant Qualifications

The applicant for this project is Mitchell Swanson Hydrology & Geomorphology located in Santa Cruz. Hydro Science, located in Vacaville is the proposed collaborator. Both are well-established firms, Swanson Hydrology founded in 1988 and Hydro Science in 1990 (Hydro Science DUNS# 61-980-6250). Both are small-businesses specializing in fluvial geomorphology, hydrology, wetlands, and watershed management. The focus of both firms is physical process hydrology and geomorphology, with an emphasis on water-landscape-soil-vegetation dynamics. Typical projects include stream and river restoration (physical aspects), assessment of channel stability and trends, wetlands design, and watershed restoration. The firm's principals, Mitchell Swanson, and Toby Hanes would share the responsibilities of principal investigator. Mitchell Swanson would be the principal-in-charge and primary administrator of the contact. We are proposing to perform the work as a joint venture, although the firms are in the process of forming a new corporation.

Mr. Swanson and Mr. Hanes have worked collaboratively on a number of projects over the last several years, and that relationship continues to expand. Both firms have excellent capabilities, including total station surveying equipment, AutoCAD, large format digitizers, stream gaging, streamflow, and sediment measuring equipment, and support of standard hydrologic, hydraulic, and sediment transport models. Hydro Science has in-house graphics production capabilities, including the production of blended-color "habitat view" representations, as well as standard engineering line drawings. Both firms are unique in that their approach to all projects is to engage the principals to perform the bulk of the work, especially field-related tasks. We believe this aspect of our approach offers a level of scrutiny and quality control that is of utmost importance in dealing with complex systems. This approach is in stark contrast to larger firms that use their senior scientists to "win" work and then hand over the technical aspects of the work to junior level personnel.

We take pride in our reputation for scientific excellence, but also bring decades of real-world, multi-resource experience, practical solutions, and an understanding of competing land use objectives. The ability of the firms to create the physical habitat required to develop and sustain ecosystems in a practical manner is frequently the prerequisite for long-term project success. Understanding the linkage between watershed condition and streamflow response, and identifying trends in the physical state of wetland and riverine systems is fundamental. Stream restoration most frequently fails by imposing a biological or physical "solution" which attempts to hold an evolving system in a static state. Our approach is to identify ongoing trends and the "potential" condition, in order to work with, rather than against, the river.

Biosketches of the principal investigators and a sample of pertinent project work follows:

Mitchell Swanson is a senior fluvial geomorphologist with over fifteen years of consulting experience related to restoration and resource management of large rivers, streams, and wetlands. He holds B.S. and M.S. degrees in earth sciences, with concentrations in fluvial geomorphology, sedimentary geology, and hydrology. He specializes in the development of technically and environmentally sound management and restoration plans for rivers and watersheds. A special focus involves the development of systematic field data collection and analysis programs tailored

to the specific needs and resources of the individual project. His technical expertise includes historical geomorphic and hydrologic studies and in determining the causes and effects of human modification on natural systems. Mr. Swanson has led efforts to integrate bioengineering and geomorphic principles into bank and stream stabilization projects. Mr. Swanson has become a recognized expert in conflict resolution between government agencies, and public and private interests.

Toby Hanes is a Registered Professional Hydrologist and Certified Professional Erosion and Sediment Control Specialist with 21 years of experience. He holds a B.S. in watershed sciences and a M.S. in Wildland Hydrology with academic concentration in natural channel hydraulics and sediment transport, physical process watershed modeling, and soil-plant-water relationships. Mr. Hanes' career includes positions as a field hydrologist with the U.S. Geological Survey and 13 years with the U.S. Forest Service, with positions at all levels of the agency from Ranger District to the Washington D.C. Office. Pertinent experience includes five years as Forest Hydrologist at the Lake Tahoe Basin Management Unit, where he was directly responsible for a number of stream and wetland restoration projects. For the last nine years, Mr. Hanes has been in private consulting and established Hydro Science in 1990. Mr. Hanes has designed and supervised construction on numerous stream and wetland restoration projects and has had two on-call services contracts with the California Tahoe Conservancy to provide such services.

Upper Truckee River Restoration Conceptual Design, South Lake Tahoe (California Tahoe Conservancy) This is a project of national significance, the core of which was performed by Swanson and Hanes. Mr. Clinton was briefed on the work to date during the recent "Presidential Summit" at Lake Tahoe. Developed the conceptual designs for the river restoration of 1.5 miles of river and 180 acres of wetlands. Performed all phases of the hydrology, geomorphic, and sediment transport studies including development of regional bankfull/hydraulic geometry relationships. This project has undergone peer review by Dr. Luna Leopold.

Lower American River Bank Stabilization Plan, Sacramento County, California (Sacramento Area Flood Control Agency) Developed a bank protection program and plans for the Lower American River near Sacramento. Prioritized erosion sites along the river and quantified historical rates of bank retreat since 1937. Tasks included historical analysis, development of geomorphic and riparian vegetation design criteria for bioengineered structures and design of aquatic enhancements. Chaired and led the facilitation of the Bank Protection Working Group that included the U.S. Army Corps of Engineers, environmental groups, state and local flood control agencies, the California Department of Fish and Game, the U.S. Fish and Wildlife Service and local flood control agencies.

Channel Restoration and Bank Stabilization on the Tuolumne River at 7/11 Materials, Inc. Stanislaus County, California In the aftermath of the January, 1997 floods, Swanson designed a channel and levee restoration plan for 8,000 feet of damaged channel in an area of gravel mining, just below the Roberts Ferry Bridge. The project included complete topographic and bathymetric surveys under high water conditions, hydraulic modeling of existing and proposed

channel features, preparation of grading plans and a design report. The proposed plan included land use and levee setbacks with plans for riparian corridor expansion, flood plain restoration and installation of bank protection structures that create Shaded Riverine Aquatic (SRA) habitat. The plan also included provisions for placing woody debris in channel for instream cover and for increasing hydraulic diversity and skimming terraces to create active channel and flood plain.

Tonto Creek Riparian Allotment Hydrologic and Geomorphic Analysis and Monitoring, Arizona (U.S. Bureau of Reclamation) Six-year project to assess the riparian and geomorphic response to reduced grazing on a 13-mile reach. Assessed historic conditions and existing trends in changes in channel morphology and influences of watershed condition on increasing trend in peak flows. Monitor channel responses due to recruitment of woody riparian vegetation.

Cold Creek Restoration Monitoring Project, Lake Tahoe Basin (California Tahoe Conservancy) Designed a data collection program to analyze channel stability of a restored reach of Cold Creek, located in South Lake Tahoe. Measured bedload, suspended load, and discharge and installed a continuous stream recorder. Developed protocol for surveying pre- and post snowmelt flow channel morphology. Conducted historical investigations of the morphology of Cold Creek prior to 1950s dam construction. Developed remedial measures for channel reaches impacted by bedload sedimentation and channel stability problems.

Snow Creek Restoration, Lake Tahoe (California Tahoe Conservancy) Prepared alternative preliminary designs in conjunction with Northwest Hydraulic Consultants for the removal of several acres of fill from a meadow adjacent to Lake Tahoe, to recreate a meadow pond near its historic location, and to restore the tributary streams (final design by Placer County).

Blackwood Canyon Streambank Stability Assessment and Preliminary Design, Lake Tahoe Basin, (California Tahoe Conservancy) Assessed stream and streambank stability on the lower portion of creek. Identified highway bridge installation as the agent that resulted in incised channel, reduced sinuosity, and macro-geomorphic factors as causes of localized bank instability. Assessed erosion rates and developed conceptual plans and cost estimates for stabilization measures using bioengineering approaches (construction of floodplain benches).

Farmington Canal Channel Stability Assessment, San Joaquin County (Stockton East Water District) Assessed likely channel response to sustained moderate and high flows resulting from the diversion of water into normally ephemeral channels. Analyzed response from several approaches including stable channel design, comparison of channel geometry to channels with similar flow regimes, and application of empirical formulas using hydraulic geometry approaches.

Instream and Riparian Treatments Evaluation, Numerous Sites, Arizona and New Mexico (U.S. Forest Service) Served as expert hydrologist/restoration specialist on a review panel in the examination of 25 riparian treatments, both structural and vegetative in order to identify key factors in the success and failure of USDA Forest Service stream restoration projects.

Compliance with standard terms and conditions

We agree to the contract terms and conditions shown in Attachment D and have submitted the required forms (attached). We would desire monthly, 30-day progress payments based upon submitted monthly invoices. Invoices would be submitted no more frequent than once a month. There would be a ten-day invoice review where the client could in writing submit comments, questions or dispute any items. Without action in the ten-day review process, the invoice shall be automatically approved for payment.

TABLE 1
CALFED CATEGORY III PROPOSAL

DESIGN CONSIDERATIONS FOR RESTORING NATURAL PROCESSES TO STREAMS AND RIVERS IN SACRAMENTO - SAN JOAQUIN BASINS

Project Phase and Task	Direct Labor Hours	Direct Salary and Benefits	Overhead Labor	Service Contracts	Materials and Acquisition Contracts	Miscellaneous and other Direct Costs	Total Cost
1-Work Plan							
Swanson	40	\$1,524	\$1,676				
Hanes	40	\$1,524	\$1,676				\$6,400
2-Surveys							
Swanson	260	\$9,905	\$10,895				
Hanes	260	\$9,905	\$10,895			\$8,000	\$49,600
3-Field Statistics Analysis							
Swanson	40	\$1,524	\$1,676				
Hanes	80	\$3,048	\$3,352			\$1,000	\$10,600
4- Regional Analysis							
Swanson	40	\$1,524	\$1,676				
Hanes	80	\$3,048	\$3,352			\$1,000	\$10,600
5. Relations Statistics							
Swanson	40	\$1,524	\$1,676				
Hanes	80	\$3,048	\$3,352				\$9,600
6. Regulation Impacts							
Swanson	150	\$5,715	\$6,285				
Hanes	150	\$5,715	\$6,285			\$2,000	\$19,715
7. Case Studies							
Swanson	150	\$5,715	\$6,285				
Hanes	150	\$5,715	\$6,285			\$2,000	\$19,715
8. Draft and Final Report							
Swanson	180	\$6,858	\$7,542				
Hanes	180	\$6,858	\$7,542			\$5,000	\$33,800
9. Workshops							
Swanson	40	\$1,524	\$1,676				
Hanes	40	\$1,524	\$1,676			\$3,000	\$9,400
10. Program Management							
Swanson	80	\$3,048	\$3,352				
Hanes	80	\$3,048	\$3,352	\$20,000		\$3,000	\$35,800
					Total Estimated Cost		\$205,230

NONDISCRIMINATION COMPLIANCE STATEMENT

COMPANY NAME

SWANSON HYDROLOGY & GEOMORPHOLOGY

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

OFFICIAL'S NAME

DATE EXECUTED

EXECUTED IN THE COUNTY OF

PROSPECTIVE CONTRACTOR'S SIGNATURE

PROSPECTIVE CONTRACTOR'S TITLE

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME

SWANSON HYDROLOGY & GEOMORPHOLOGY

Agreement No. _____

Exhibit _____

**NONCOLLUSION AFFIDAVIT TO BE EXECUTED BY
 BIDDER AND SUBMITTED WITH BID FOR PUBLIC WORKS**

STATE OF CALIFORNIA)

)ss

COUNTY OF SANTA CRUZ

Mitchell Swanson, being first duly sworn, deposes and
 (name)

says that he or she is Principal / Owner of
 (position title)

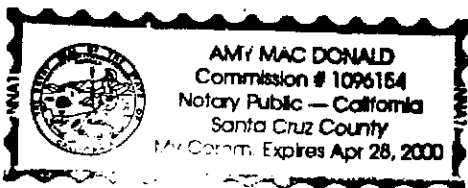
Swanson Hydrology & Geomorphology
 (the bidder)

the party making the foregoing bid that the bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the bid is genuine and not collusive or sham; that the bidder has not directly or indirectly induced or solicited any other bidder to put in a false sham bid, and has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or that anyone shall refrain from bidding; that the bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder, or to secure any advantage against the public body awarding the contract of anyone interested in the proposed contract; that all statements contained in the bid are true; and, further, that the bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, or paid, and will not pay, any fee to any corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham bid.

DATED: July 25, 1997

By

(person signing for bidder)



(Notarial Seal)

Subscribed and sworn to before me on

July 25th, 1997
 (Notary Public)